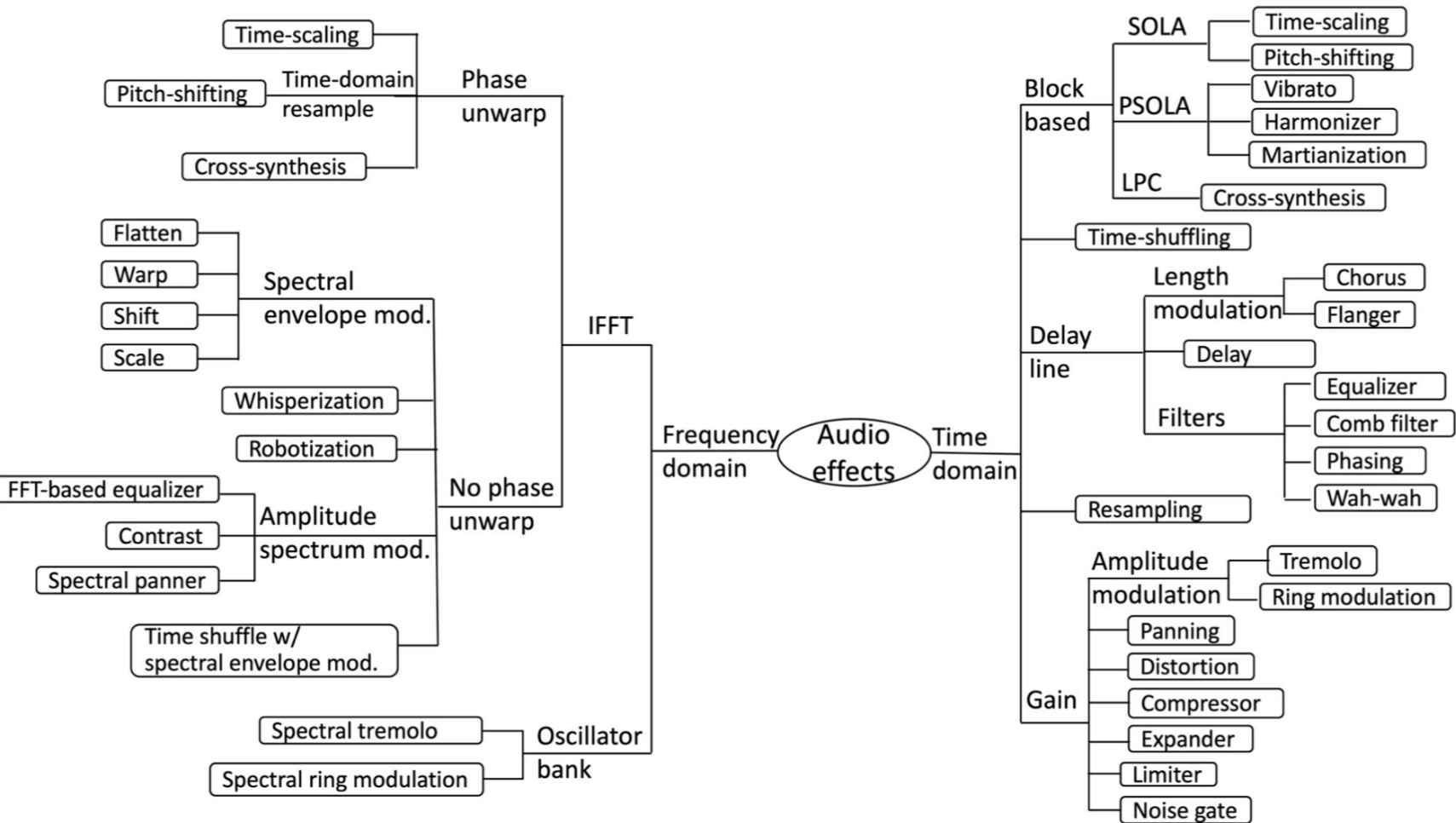
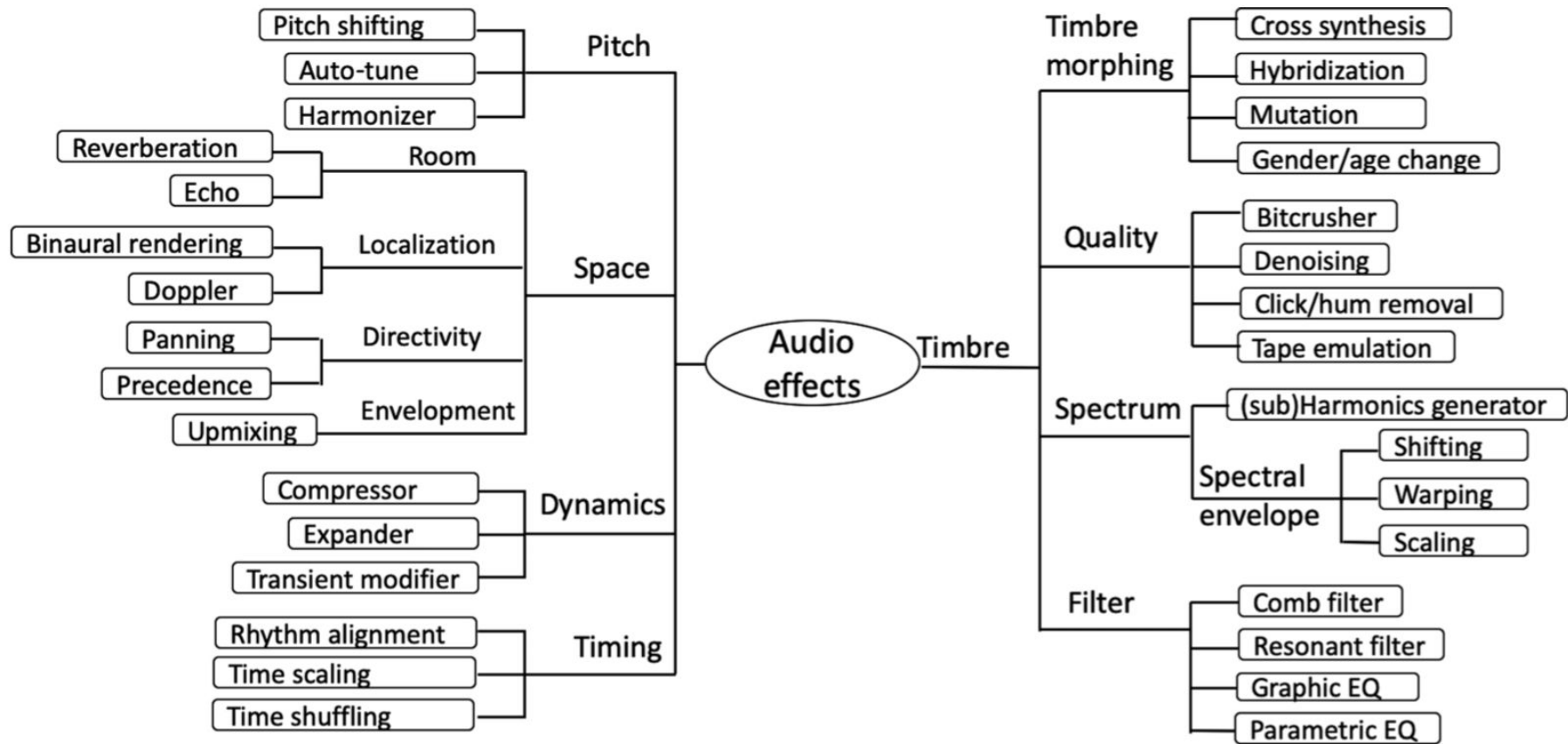


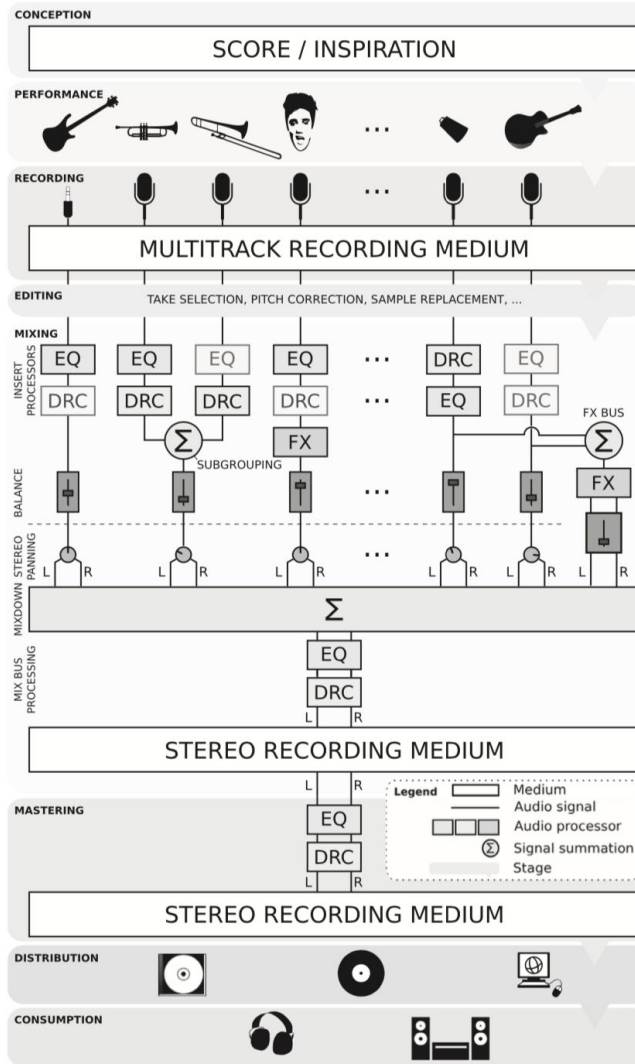
# 自动混音

李克镡

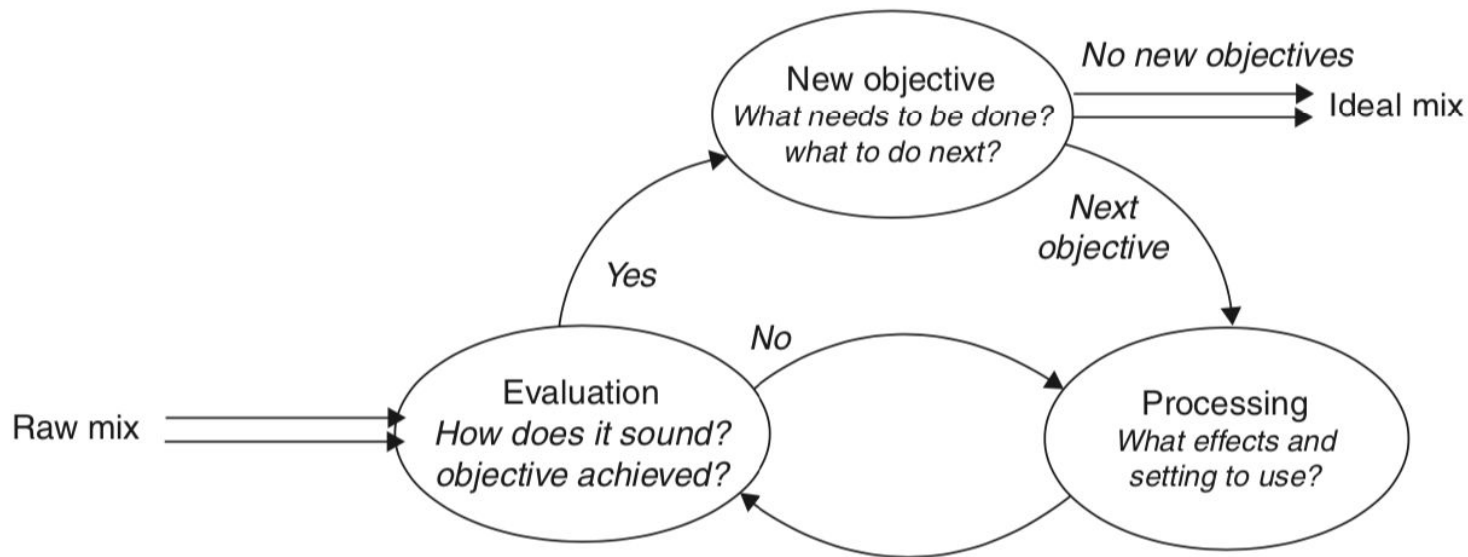




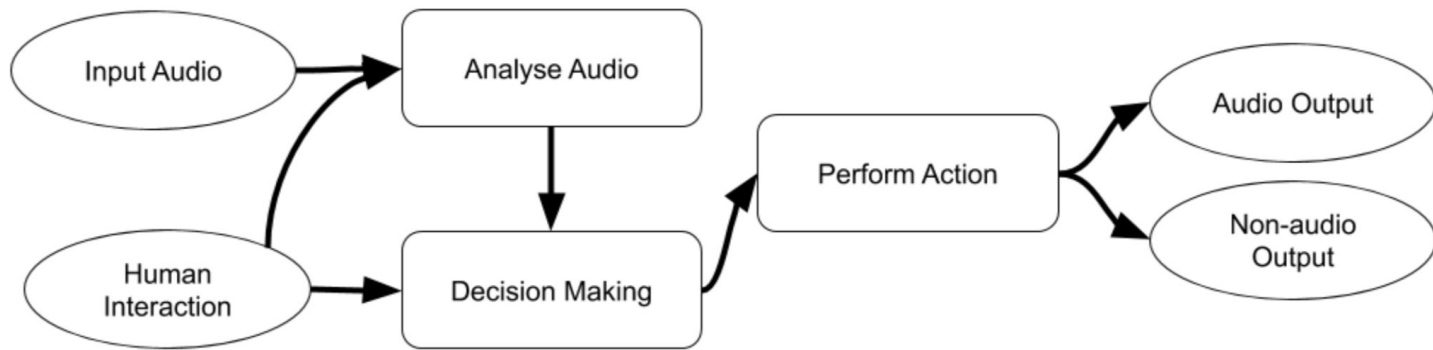




# 人类混音流程



## 自动混音流程



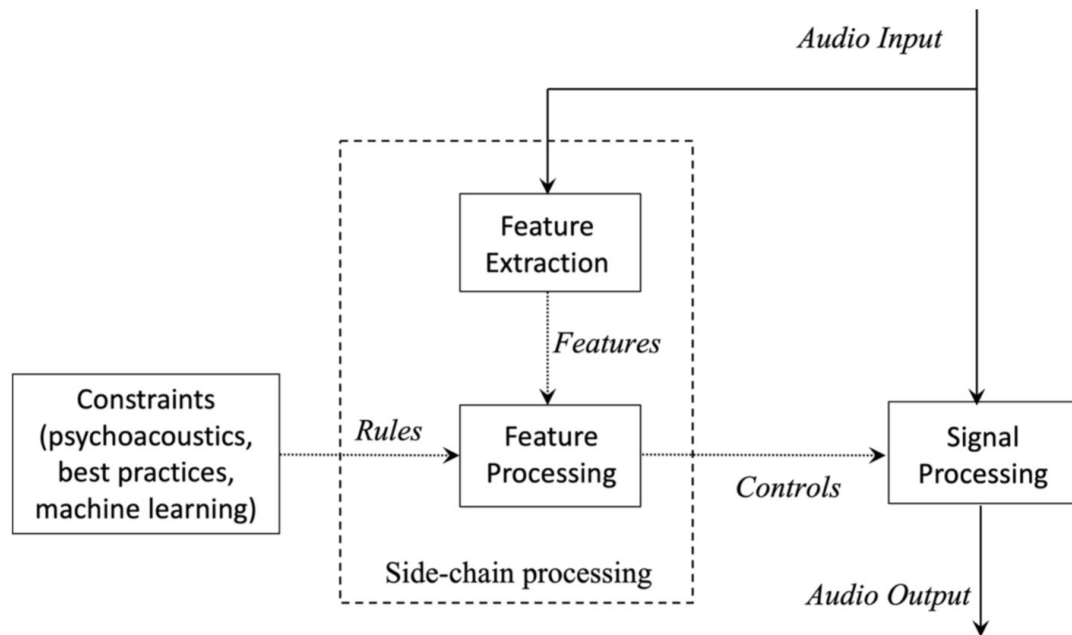
**Figure 1.** A generalised flow diagram of a intelligent music production tool.



## 音频处理

- 自适应(Auto-adaptive) — 分析本轨道的输入信号
- 外适应(External-adaptive) — 分析本轨道和其他轨道的输入信号
- 反馈适应(Feedback-adaptive) — 分析输出信号
- 交叉适应(Cross-adaptive) — 分析本轨道和其他轨道的输入信号, 本轨道信号也用于影响其他轨道
- 直接音频转换(direct audio transformation)省去了传统效果器作为中介。整个系统也不需要学习理解效果器的各个参数。

## 自适应(Auto-adaptive) — 分析本轨道的输入信号



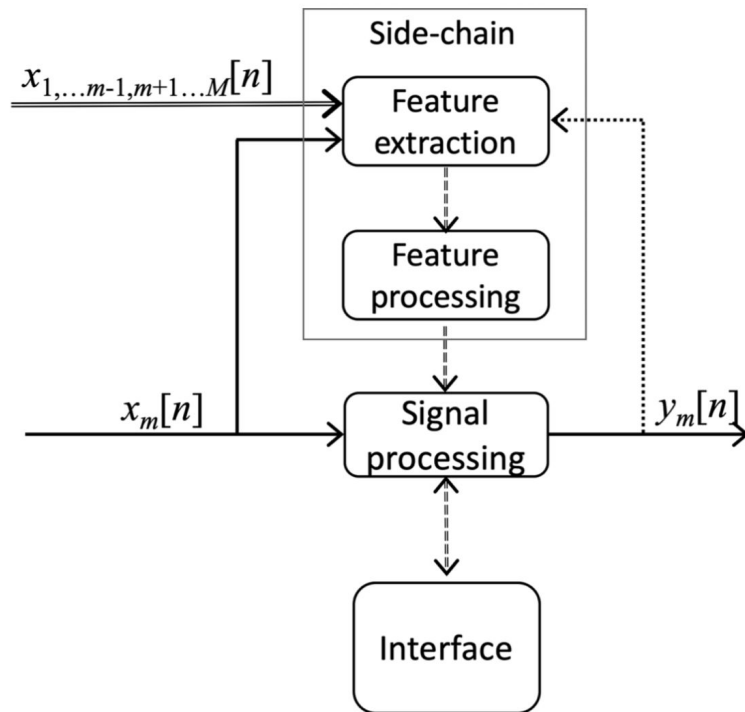


外适应(External-adaptive)

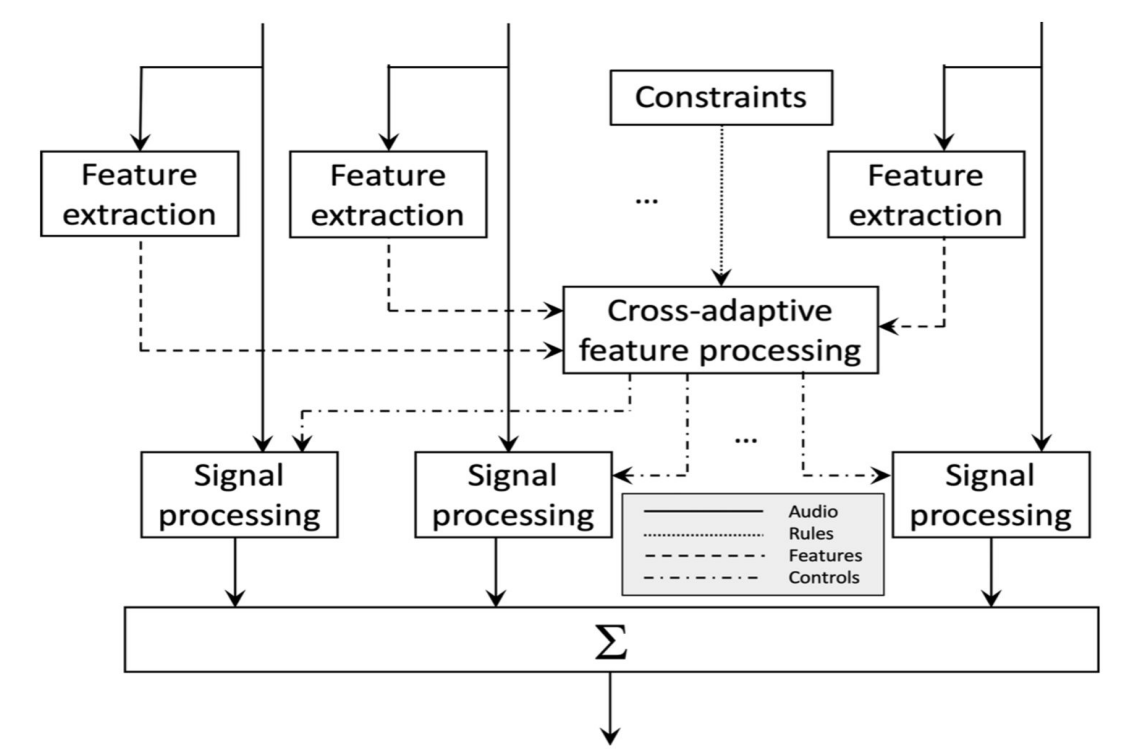
分析本轨道和其他轨道的输入信号

反馈适应(Feedback-adaptive)

分析输出信号



交叉适应(Cross-adaptive) —分析本轨道和其他轨道的输入信号，本轨道信号也用于影响其他 轨道





# 知识表示

## 法则学派

扎根理论(Grounded Theory)在实践中获取数据,总结规则。

专家系统根据预定规则来运行。

规则可以是if-then-else形式,也可能需要通过优化解决。

## 数据驱动

将音频特征映射到效果器参数上。

Table 7.1 Classification of intelligent audio production tools

Single or multitrack	Audio effect	Reference	Real-time	Rules
Single track	Equalization	[52]	Yes	Mix analysis
		[186, 260–264]	No	Machine learning
		[51]	Yes	Best practices
	Compression	[53, 59, 60]	Yes	Psychoacoustics; Best practices
		[66]	No	Machine learning
	Reverberation	[65, 69, 187, 265, 266]	No	Machine learning
Multitrack	Distortion	[56]		Best practices
	Faders and gains	[38, 39, 46]	Yes	Best practices
		[41, 47, 50, 57, 64]	No	Best practices
		[68]	No	Machine learning
		[44]	No	Machine learning
	Equalization	[40, 61]	Yes	Best practices
	Compression	[48, 62]	Yes	Psychoacoustics; Best practices
	Stereo panning	[36, 43, 49, 58]	Yes	Best practices
	Reverberation	[70]	No	Best practices; Machine learning
	Full mix	[54, 55, 71, 155, 162]	No	Best practices; Machine learning

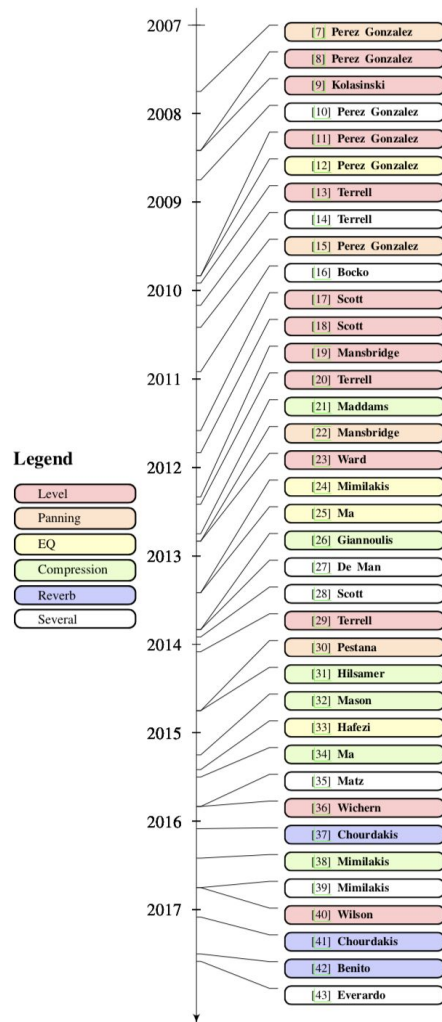


Figure 1: Timeline of prior work 2007–2017

## Multitrack

### Black Box

#### PANNING

[7] E. Perez Gonzalez and J. D. Reiss, "Automatic mixing: live downmixing stereo panner," 7th Int. Conf. on Digital Audio Effects (DAFx-07), Sep 2007.

## Single-track

#### LEVEL

[8] E. Perez Gonzalez and J. D. Reiss, "An automatic maximum gain normalization technique with applications to audio mixing," Audio Engineering Society Conv. 124, May 2008.

## Multitrack

#### LEVEL

[9] B. Kolasinski, "A framework for automatic mixing using timbral similarity measures and genetic optimization," Audio Engineering Society Conv. 124, May 2008.

## Multitrack

### SEVERAL

[10] E. Perez Gonzalez and J. D. Reiss, "Improved control for selective minimization of masking using inter-channel dependency effects," 11th Int. Conf. on Digital Audio Effects (DAFx-08), Sep 2008.

## Multitrack

#### LEVEL

[11] E. Perez Gonzalez and J. D. Reiss, "Automatic gain and fader control for live mixing," IEEE Workshop on Applications of Signal Processing to Audio and Acoustics, Oct 2009.

<https://docs.corp.kuaishou.com/d/home/fcAB8zYGpFACv-K76B49i8tzn>



# An Automated Approach to the Application of Reverberation

Mixing Rule	Ref.
<b>Mixing Rule 1.</b> <i>There is a strong correlation between tempo of a song and RT60.</i>	[17]
<b>Mixing Rule 2.</b> <i>A slower song will require a longer reverb.</i>	[17]
<b>Mixing Rule 3.</b> <i>Typical reverb times (RT60) will not be longer than around 3s.</i>	[15]
<b>Mixing Rule 4.</b> <i>It is better to err on the side of too little reverb, rather than too much.</i>	[19]
<b>Mixing Rule 5.</b> <i>For a higher perceived amount of reverberation, increase the reverb loudness and/or reverb time.</i>	[20]
<b>Mixing Rule 6.</b> <i>Reverb time is strongly dependent to an autocorrelation measure.</i>	[20]
<b>Mixing Rule 7.</b> <i>The pre-delay is timed as a multiple of the subdivided song tempo.</i>	[20, 21]
<b>Mixing Rule 8.</b> <i>The pre-delay should be over the Haas fusion point</i>	[20]
<b>Mixing Rule 9.</b> <i>Low-end frequencies are less tolerant of reverb and delay.</i>	[20]
<b>Mixing Rule 10.</b> <i>Transients are less tolerant of reverb and delay.</i>	[20]
<b>Mixing Rule 11.</b> <i>The sends into the reverbs should be equalised.</i>	[20]
<b>Mixing Rule 12.</b> <i>The level of the reverb returns is on average set to a specific amount of True loudness lower than the direct sound.</i>	[20]

利用总结的混响使用规则，以近似于一一对应方式  
设置混响参数

音乐速度控制diffusion和tail decay，进而控制混响时间

<https://docs.corp.kuaishou.com/d/home/fcABZXR19oTQqGRSezZhIPctF>

## Autonomous Multitrack Equalization Based on Masking Reduction

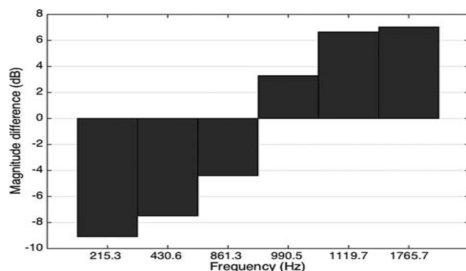


Fig. 2. This shows the difference in magnitude (M value) between the horn (maskee) and cello (masker) tracks at those frequencies that are essential for the horn but nonessential for the masker. Positive values imply that masking reduction is needed.

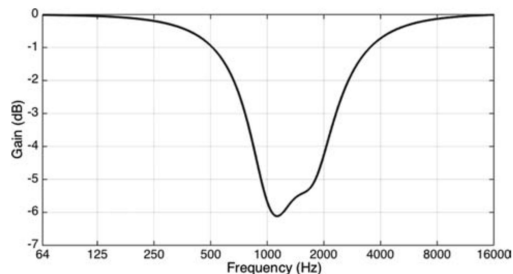
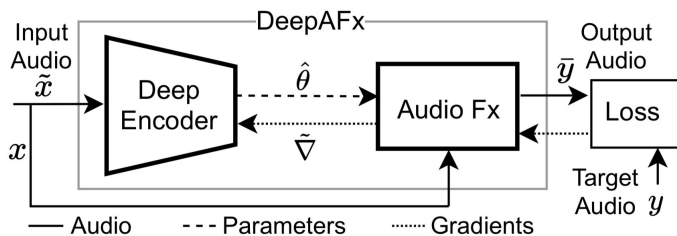


Fig. 3. The fully autonomous ( $S = 0$ ) equalization filter applied to the cello track in order to reduce masking of the horn track.

- (1) 遮蔽轨道在一频段振幅高于被遮蔽轨道的内容；
- (2) 该频段是被遮蔽轨道的主要内容，并且是遮蔽轨道的次要内容。

## Differentiable Signal Processing With Black-Box Audio Effects



**Fig. 1.** Our *DeepAFx* method consists of a deep encoder that analyzes audio and predicts the parameters of one or more black-box audio effects (Fx) to achieve a desired audio processing task. At training time, gradients for black-box audio effects are approximated via a stochastic gradient method.

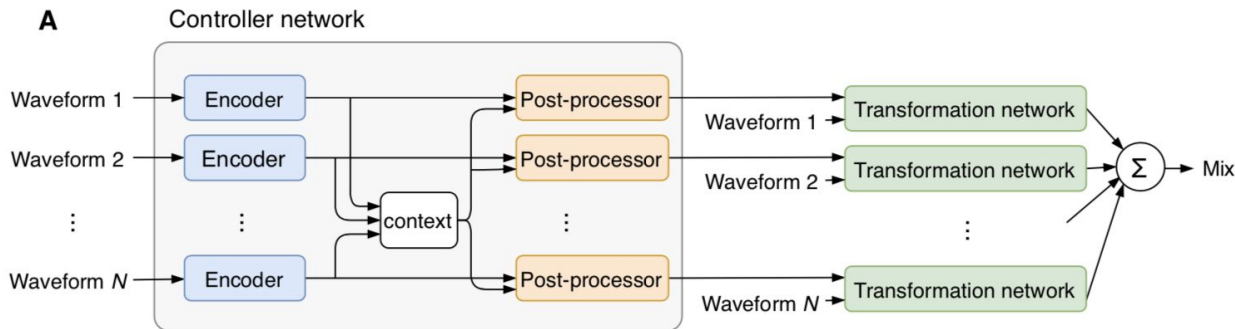
在神经网络中使用任意第三方黑箱音频插件的可微分信号处理。

1. 编码器用于分析输入音频并控制音频插件。
2. 对于不可微分的黑箱音频效果, 使用了一个高速平行随机梯度近似以及一个标准自动微分图(auto differentiation graph)

自动母带处理使用多段压缩、均衡和限制器



## Automatic Multitrack Mixing With A Differentiable Mixing Console Of Neural Audio Effects



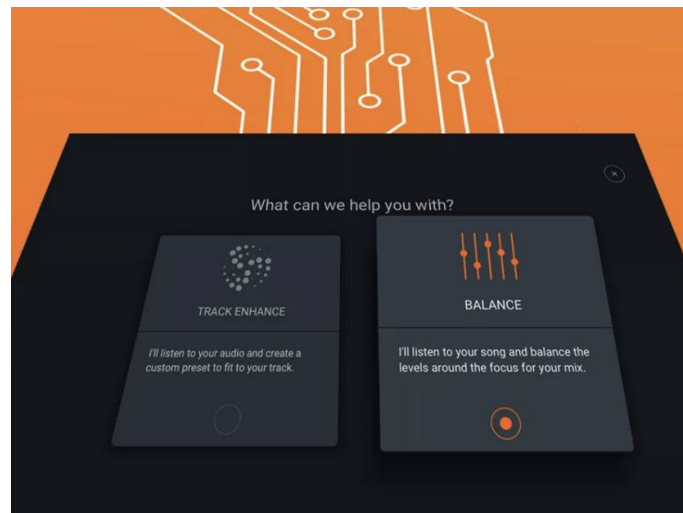
用神经网络模拟替代每个轨道原有的信号处理, 再训练控制网络

效果存疑

<https://docs.corp.kuaishou.com/d/home/fcAC0WWpfyoQCA54M0LL6smgg#>

# 自动混音

iZotope Neutron



# 自动母带

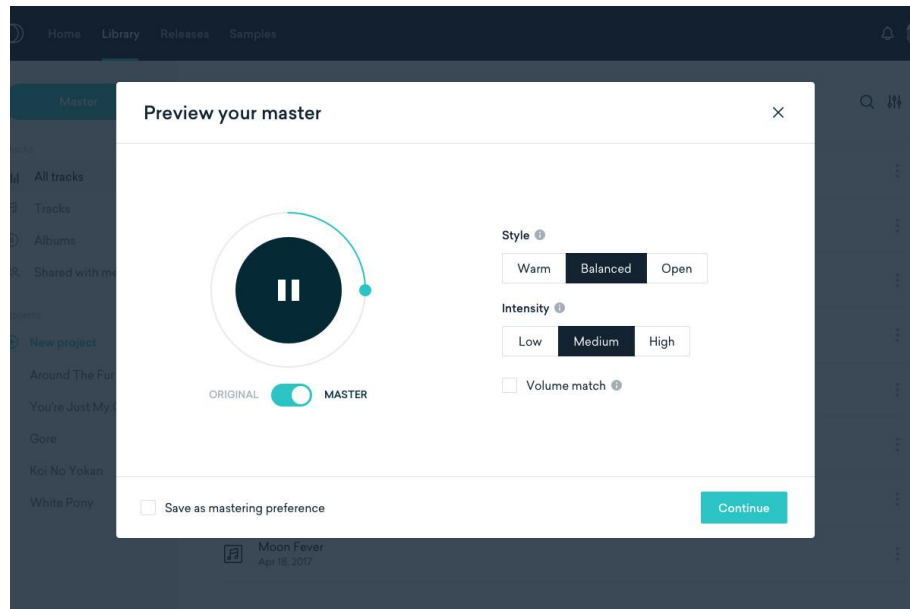
Landr

SoundCloud + Dolby

eMastered

Bandlab

iZotope Ozone





US009654869B2

(12) **United States Patent**  
**Reiss et al.**

(10) **Patent No.:** **US 9,654,869 B2**  
 (45) **Date of Patent:** **May 16, 2017**

(54) **SYSTEM AND METHOD FOR  
 AUTONOMOUS MULTI-TRACK AUDIO  
 PROCESSING**

(71) Applicant: **MixGenius Inc.**, Montreal (CA)

(72) Inventors: **Joshua D. Reiss**, London (GB); **Stuart  
 Mansbridge**, Penrith (GB); **Alice  
 Clifford**, Stapleford (GB); **Zheng Ma**,  
 London (GB); **Sina Hafezi**, London  
 (GB); **Nicholas Jillings**, Dorking (GB)

(73) Assignee: **LANDR AUDIO INC.**, Montreal, QC  
 (CA)

(\* ) Notice: Subject to any disclaimer, the term of this  
 patent is extended or adjusted under 35  
 U.S.C. 154(b) by 156 days.

(21) Appl. No.: **14/398,990**

(22) PCT Filed: **May 7, 2013**

(86) PCT No.: **PCT/GB2013/051184**  
 § 371 (c)(1),  
 (2) Date: **Nov. 5, 2014**

(87) PCT Pub. No.: **WO2013/167884**  
 PCT Pub. Date: **Nov. 14, 2013**

(65) **Prior Publication Data**  
 US 2015/0117685 A1 Apr. 30, 2015

(30) **Foreign Application Priority Data**  
 May 8, 2012 (GB) ..... 1208012.3

(51) **Int. Cl.**  
**H04R 5/02** (2006.01)  
**H04R 3/00** (2006.01)

(52) **U.S. Cl.**  
 CPC ..... **H04R 3/00** (2013.01); **G11B 27/031**  
 (2013.01); **H03G 3/32** (2013.01); **H04R 5/04**  
 (2013.01)

(58) **Field of Classification Search**  
 CPC ..... G11B 27/031; H04R 3/00; H04R 5/04;  
 H03G 3/32

(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,414,776 A \* 5/1995 Sims, Jr. .... H04H 60/04  
 7,825,322 B1 11/2010 Classen et al. 379/202.01

(Continued)

FOREIGN PATENT DOCUMENTS

GB 2500790 A 10/2013  
 WO 2011/034520 A1 3/2011

OTHER PUBLICATIONS

Daniele Barchiesi et al: "Automatic Target Mixing Using Least-  
 Squares Optimization of Gains and Equalization Settings", Proc. of  
 the 12th Int. Conference on Digital Audio Effects (DAFx-09),  
 Como, Italy, Sep. 1-4, 2009 (Sep. 1, 2009 to Sep. 4, 2009), pp. 1-8.  
 (Continued)

*Primary Examiner* — Paul S Kim

(57) **ABSTRACT**

A method, apparatus, and computer readable medium for  
 mixing a plurality of audio signals within an audio mixing  
 system are disclosed. The method comprises receiving a  
 plurality of audio signals, extracting at least one audio  
 feature from each of the plurality of audio signals, deter-  
 mining, for each of the audio signals, an associated process-  
 ing control function in accordance with a plurality of the  
 extracted audio features, processing each audio signal in  
 accordance with each associated processing control func-  
 tion, and outputting the plurality of processed audio signals.



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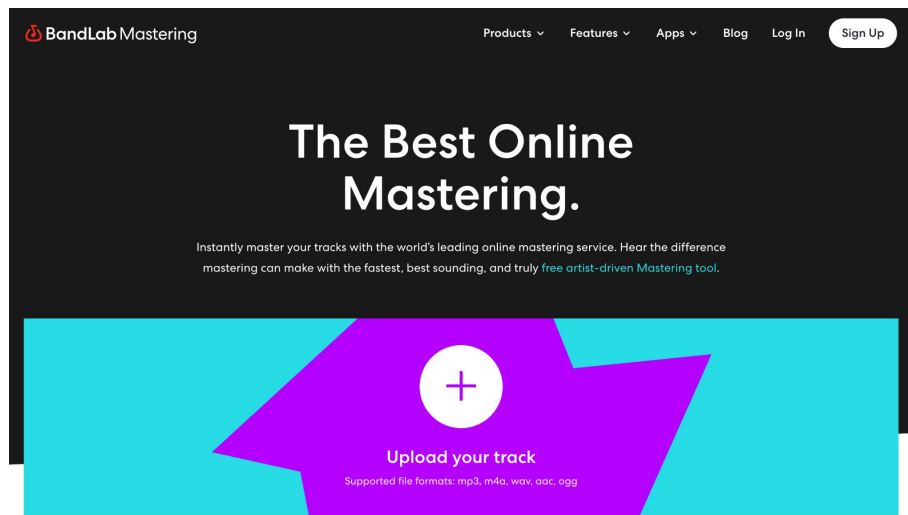
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# 自动母带

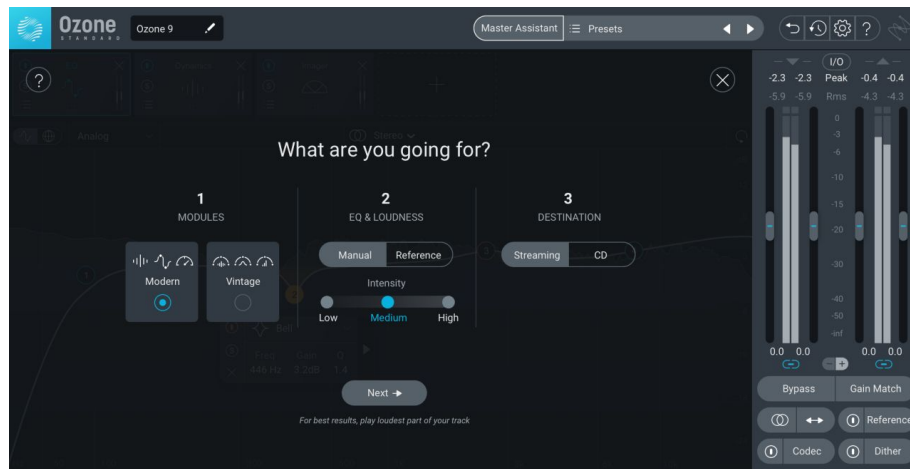
Landr

SoundCloud + Dolby

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Bandlab

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# 多轨数据集

1

[www.conversesamplelibrary.com](http://www.conversesamplelibrary.com)

2

[www.Davidglennrecording.com](http://www.Davidglennrecording.com)

3

[www.duelingmixes.com](http://www.duelingmixes.com)

4

[www.mixoff.org](http://www.mixoff.org)

5

<https://weathervanemusic.org/shakingthrough>

6

<https://telefunken-elektroakustik.com/multitracks>

7

[www.ultimatemetal.com/forum](http://www.ultimatemetal.com/forum)

8

[www.mtg.upf.edu/static/mass/resources](http://www.mtg.upf.edu/static/mass/resources)

9

<https://sites.google.com/site/unvoicedsoundseparation/mir-1k>

10

[www.tsi.telecom-paristech.fr/aao/en/2012/03/12/quasi](http://www.tsi.telecom-paristech.fr/aao/en/2012/03/12/quasi)

11

<https://sigsep.github.io>

12

[www.native-instruments.com/en/specials/stem](http://www.native-instruments.com/en/specials/stem)  
[s](#)

# 数据集



## 语义数据集

13

<http://semanticaudio.co.uk>

14

<http://music.cs.northwestern.edu/research.php>

## 其他相关数据集

15

[www.idmt.fraunhofer.de/en/business\\_units/m2d/smt/audio\\_effects.html](http://www.idmt.fraunhofer.de/en/business_units/m2d/smt/audio_effects.html)

16

[www.audiocontentanalysis.org/data-sets](http://www.audiocontentanalysis.org/data-sets)

17

<http://ismir.net/resources.html>

18

<https://labrosa.ee.columbia.edu/millionsong>

19

<https://compmusic.upf.edu/datasets>

20

<https://freesound.org>

# 多轨数据集

Songs								
Title ▲	Artist ▲	Composer ▲	Song Type ▲	Recording Engineer ▲	Recording Date ▲	Number of Tracks ▲	Number of Mixes ▲	Number of Stems ▲
Upper Hand	Patrick Talbot		studio music		—	31	48	0
All the Gin is Gone	Maurizio Pagnutti Sextet	Stefano Amerio	studio music		—	16	9	0
Funky to the Bone	W.I.N.D.	Stefano Amerio	studio music		—	43	13	0
Poor Boy	Wesley Morgan		studio music		—	16	7	0
Inner Circle	Lead Inc.	Lead Inc.	studio music	Henrik Michalzik	—	47	58	0
Just Don't Talk	Timo and the Time Zone		studio music		—	27	7	0
Happy Blues	Tommy Marcinek		studio music		—	19	10	0
Ayni Nehirde	Qupe		studio music		—	28	23	0
Better?	Triviul		studio music		—	28	9	0
Trude the Bumblebee	Don Camillo Choir		studio music		—	20	8	0
Mama Llama	unknown band	Guitar Zero	studio music	Guitar Zero	—	13	8	0
Watered Down Whiskey	Kristen Brassel		studio music	Chase Slagle	—	29	7	0
Rainbow Jane	Eric Block	Eric Block	studio music	Eric Block	—	29	8	0

Open Multitrack Testbed  
<http://multitrack.eecs.gmul.ac.uk/>

Table 5.1 Table of existing multitrack resources, with estimated number of songs, whether (some) multitracks are available under a Creative Commons license or are in the public domain, and whether they are freely available

Name	# songs	CC	Free	Ref.
BASS-dB	20	✓	✓	[165]
Bass Bible	70			[166]
Converse Rubber Tracks		(✓)	(✓)	1
David Glenn Recording			(✓)	2
Dueling Mixes				3
DSD100	100		✓	[167]
MASS		✓	✓	[168]
MedleyDB	122	✓	(✓)	[169]
MIR-1K	1000		✓	[170]
Mix Evaluation	19	✓	✓	[139]
Mixing Secrets	180		✓	[129]
MixOff.org			✓	4
MIXPLORATION	3			[405]
MUSDB18	150	(✓)	(✓)	[171]
QUASI	11	(✓)	✓	[172]
Rock Band	48		(✓)	[173]
Shaking Through	50	✓		5
Structural Segmentation	104	(✓)	✓	[174]
Telefunken Microphones			✓	6
TRIOS	5	✓	✓	[175]
Ultimate Metal Forum			✓	7

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<https://docs.corp.kuaishou.com/s/home/fcABhjFUvpk3WzHSftCYJ1NiT>



# 问题?

李克镡

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[www.likelian.net](http://www.likelian.net)